Using Drones to Detect Damage to Bridges Workshop

Summary Report

December 13, 2018 | 9:00 AM- 12:00 PM
Lakewood, WA

Workshop Summary
The Pacific Northwest Economic Region and its Center for Regional Disaster Resilience in partnership with Northeastern University's Global Resilience Institute (GRI) were awarded a 2017 National Infrastructure Protection Plan (NIPP) Security and Resilience Challenge grant for critical infrastructure. This workshop will present the results of the technical research team (GRI) at utilizing self-directed drone technology (algorithms) and LIDAR to inspect damaged bridges in a post-disaster scenario.

Welcome and Introductions
Opening Remarks

Eric Holdeman, Director for the Center for Regional Disaster Resilience, opened the workshop by welcoming attendees and facilitated introductions of all participants. He then gave an overview of the workshop and its intended purpose to present the final technical report from Northeastern University's work on the National Infrastructure Protection Plan (NIPP) Challenge Project focused on using Unmanned Aerial Systems for damage assessments. Mr. Holdeman explained that the workshop would be more technical in nature and was geared toward those involved in inspecting critical infrastructures in the event of a disaster, specifically bridge inspectors.

Mr. Holdeman gave a background on the NIPP project stated above and the Center for Regional Disaster Resilience's (CRDR) road to receiving the grant as well as the steps taken to fulfill the requirements of the project. Mr. Holdeman introduced the partnership with Northeastern University's Global Resilience Institute and their role in developing the technical side of the project while CRDR established a drone users' group to determine who is using drones and how they are being used, as well as holding several workshops and a webinar.

Update on Drone Regulations and Usage in the Northwest

Tom Hagen, President of Association for Unmanned Vehicle Systems International Cascade Chapter, was invited to the stage next to give an update on drone regulations and usage in the Northwest. Mr. Hagen went through the recent FAA Reauthorization Act of 2018 which is a five-year reauthorization bill and explained the provisions that relate to drones and their usage. He highlighted the repeal of Section

336 of the act which was a special provision for recreational and hobby users of unmanned aerial systems (UAS)--or drones as they are more commonly referred to--to ensure that hobbyists were not burdened by the regulations that applied to more formalized and commercial UAS use. This repeal was protested, but ultimately, Mr. Hagen believes that it will be beneficial to the industry. Mr. Hagen went on to explain the updates or changes from previous reauthorizations and what that means for drone users, both recreational and commercial.

Mr. Hagen then went on to describe the various uses for drones, including the areas and industries in which they could be utilized most effectively. He mentioned four categories specifically and explained how drones could be used to aid and improve each area.

- He began with infrastructure inspections including oil and gas, utilities, construction, and insurance. Using drones for infrastructure inspections can reduce the need to put people in unsafe or unknown situations and make it easier and safer to assess damage.
- Secondly, Mr. Hagen talked about the use of drones for precision agriculture which he broke down into visual, multispectral, and remote sensing. Drones can be used in agriculture to give farmers a better, overall view of their land and its needs which can save money, water, and other resources.
- Thirdly, drones can be used in resource management to allow an overview of resources including inspecting land for invasive species and wildlife, monitoring wildfires, and observing other issues that cannot easily be detected or accessed from the ground.
- Lastly, Mr. Hagen brought up the benefits of drones for package delivery and urban mobility. Drones are already being used in third world countries to deliver aid relief and other similar operations. Mr. Hagen believes these services will likely begin to be implemented in the U.S. in the future. However, rules and regulations governing air space will needed to be changed to allow for these new services. Additionally, he mentioned the eventual use of drones as a sort of airborne taxi service to help reduce traffic congestion.

Mr. Hagen concluded by providing a list of UAS users that operate in the Pacific Northwest.

Flight Operations

Next to the stage was **David Tyler**, Manager of IT/ Telecommunications for Puget Sound Energy (PSE), who spoke on the development and implementation of Puget Sound Energy's Aerial Operations Program. This program, while still in test mode, introduced PSE to the concept of using aerial systems for damage

assessment and inspections. PSE's program made use of several different aerial systems including drones, helicopters, and airplanes. LIDAR was also employed. The intention of the aerial operations program was to serve as an aid to ground crews by allowing them a clearer and more complete view of operations, damage to these operations, and potential dangers or problems that might occur.

In the course of his presentation, Mr. Tyler revealed that employing drones in surveying actually created more work than anticipated for the program employees rather than reducing the workload as intended. This, in part, led PSE to postpone the use of drones as part of their program. A secondary factor was the effectiveness of drones in inclement weather. A drone can be less effective for damage assessment in the presence of wind, precipitation, and cold temperatures. Due to these factors, PSE determined that drones could not fulfill their needs at the time and would instead make more extensive use of helicopter and airplane footage.

After a brief question and answer period, attendees were dismissed for a short break.

Report on Technical Tools for Post-Disaster Damage Assessment

After the break, **Dr**. **Taskin Padir**, Associate Professor of Electrical and Computer Engineering at Northeastern University, began his presentation which covered technical elements of the NIPP Security and Resilience Challenge project. Dr. Padir started with a description of the project and the role his engineering team played in the scope of the project. The Resilience Challenge project was inspired by the needs that arise following a disaster which Dr. Padir explained was a good way to bring his team together on a new topic they haven't worked on in the past.

Following the Fukushima nuclear disaster in Japan, Dr. Padir worked with DARPA on the DARPA Robotics Challenge which was conducted in the aftermath of the disaster. Dr. Padir pondered how much better would it have been if a drone could have been sent to assess the damage to the nuclear reactors rather than humans. This and other disasters like it act as motivation for post-disaster research to reduce the danger of assessing critical infrastructure post-disaster. While drones are beginning to be used in disaster scenarios, limitations still exist for drones. The particular goal of the NEU team's research was to try to discover a way to reduce these limitations and make drones more effective and practical for use in post-damage assessment.

The main problem with operating a drone, according to Dr. Padir, is the human component. Humans are limited by their operational skill. The NEU team's solution was to develop a robotic system to operate the drone that would reduce or eliminate the human errors that could occur. The university built a drone cage for the project to aid in research and testing with a goal to work toward fully autonomous control of the drone. From here, Dr. Padir proceeded to walk the workshop attendees through the team's research,

process, and testing. He presented photos and videos to demonstrate and illustrate the various elements of the team's work.

Dr. Padir closed his presentation by answering questions from the audience. When asked by a participant about the level of granularity the sensors could track cracks on concrete, Dr. Padir stated that right now the sensors are looking at centimeters and cannot detect millimeters of damage yet. On the topic of sensors, while the drones used for this project only utilized one sensor, a participant asked whether multiple sensors or drones could be employed to survey the same infrastructure or area to which Dr. Padir replied that could definitely happen. Another participant wanted to know how much of these mapping systems and algorithms are made available through open source platforms and why it was necessary for Dr. Padir's team to develop their own. The participant used the example of a Roomba vacuum which employs sensors to detect its surroundings and asked what the difference was. Dr. Padir acknowledged that the underlying technology is similar; however, the difference has to do with the space in which each system operates--2D vs. 3D. Dr. Padir's team was concerned with 3D sensing which is not being as widely used. When asked when this research could be implemented in a real-world scenario, Dr. Padir stated that the technology is still being developed and cannot be implemented on a commercial level as of yet but could be commercially viable in, perhaps, two years.

Introduction of 2019 National Infrastructure Protection Plan Resilience Challenge

At the conclusion of Dr. Padir's presentation and question period, **Eric Holdeman** once again took to the stage to introduce the CRDR's next NIPP Resilience Challenge grant project which will address using drones for synchronization of situational awareness. The goal of this project is to establish an access methodology for how public and private sector organizations gain access to their critical infrastructure following a disaster. This project applies to four states--Washington, Oregon, Montana, and Idaho. The CRDR will hold a workshop in each of the four states in conjunction with each state's emergency management offices and develop a CONOPS for each state.

Business Re-Entry (BRE) Registration

Tristan Allen, Program Manager for Washington State Emergency Management, presented next on the Washington State system instituted to assist the private sector, primarily, to regain entry to their critical infrastructure or business following a disaster. This Business Re-Entry Registration (BRE) allows organizations to pre-register with the state to allow for quicker and smoother access to their infrastructure after a disaster. After an event, this system provides law enforcement or other entities quickly and easily verify that identify the organization and allow them access at their discretion. Mr. Allen walked the attendees through the process of eligibility, registration, and navigation of the system and explained that benefits of pre-registering through the system.

NHERI RAPID Facility

The last speaker of the day, **Jake Dafni,** Operations Manager for NHERI RAPID Experimental Facility at the University of Washington, gave an overview on the University of Washington's NHERI RAPID Facility which is a National Science Foundation-funded organization. The NHERI (Natural Hazards Engineering Research Infrastructure) RAPID Facility is a field-based, reconnaissance-based facility. Mr. Dafni stated the mission of the facility is address the grand challenges to critical infrastructure and provide the public and private sector and communities with publicly available solutions. Community resilience and infrastructure resilience are the two main issues that the facility seeks to address. The specific purpose of the facility is to acquire, maintain, and operate state-of-the-art information collection

tools that can be utilized by the public and private sector to address challenges to infrastructure in their communities. They provide advisory services as well as an option to collect data for communities if need be. Otherwise, they provide the training and support to allow entities to collect the data for themselves using the facility's equipment and programs. The facility's tools include survey equipment, LIDAR scanners, drones, seismic instrumentation, wind and storm surge instrumentation, social science recon equipment, imaging equipment, software and data processing tools, and more. Mr. Dafni then went into more detail about the fleet of drones that the NHERI RAPID Facility maintains from smaller drones to larger, industrial drones to a commercialized, LIDAR-scanning drone. Mr. Dafni finished by discussing the real-world applications of the facility's tools and operations and what direction it might take in the future.

Next Steps

Transportation and utility inspectors in attendance agreed to stay connected with Dr. Padir as the technology is refined and further developed. A project website for the technical work has been established at http://www.coe.neu.edu/research/radar/index.html

PNWER will continue to facilitate the UAS Task Force/Users Group as we move toward the phase II project in 2019. Similar groups will be set up on ID, OR and MT. Members will connect via conference phone as well as in person during upcoming workshops and the scheduled drill in 2019. WSDOT will continue to co-facilitate the group in Washington.

The current UAS Task Force/ Users Group members are listed on the next page.

UAS Users Group - Jan. 2019

Organization	Name	Title
443 Consulting LLC	Ernie Hayden	Founder/Principal
Apex Engineering, PLLC	Aaron Blaisdell	Principal Land Surveyor
Applewhite Aero	Paul Applewhite	President
AUVSI Cascade Chapter	Tom Hagen	President
Big Bend Community College	Byron Noel	Program Coordinator
Big Bend Community College	Byron Noel	Unmanned Systems Program Coordinator
Center of Excellence for Aerospace & Advanced Manufacturing	Sue Bradshaw	Program Director
Center of Excellence for Aerospace Advanced Manufacturing	Mary Kaye Bredeson	Executive Director
Central Kitsap Fire & Rescue	Steven Davison	Training Officer
Central Pierce Fire and Rescue	Dale Benning	Training Captain
Central Washington sUAS	Keith Conley	Owner
Chehalis Centralia Airport	Brandon Rakes	Airport Operations Coordinator
Chicago Police Department	Kenneth Adair	Police Officer
City of Edmonds	Jeff Whatmore	GIS Tech
City of Redmond Fire Dept./EMD	Janeen Olson	Fire Program Coordinator
CITY OF SEATTLE DEPARTMENT OF TRANSPORTATION	KEN EWALT	CONCRETE MANAGER / EMERGENCY RESPONSE
City of Yakima	Sean Davido	Community Relations Specialist
Consulate of REPUBLIC of MALTA	Amb. William H. Weiss, MA, JD	Consul
Cowlitz and Wahkiakum County DEM	Dave	Basham
Disaster Medicine Project	Robert Mitchell, MD	Director of Community Disaster Medicine
Eagle-Eye Aerial Solutions, LLC	Sam Adams	Owner
Eastside Fire & Rescue	Jon Bromberg	COM-l/COM-T Fire Corps Program Mgr.
End State Solutions LLC	Charlton Evans	Principle
Forming a LLC for business	Barbara Carson Hamer	CEO
Graham Fire & Rescue	Shawn Gregory	Firefighter/Paramedic
Graham Fire and Rescue	Derick Soland	Firefighter/EMT

Green Hippo Drones	Tad Doviak	CTO
Hensel Phelps	Carlos	VDC Engineer
Jefferson County	Matt Stewart	Road Maintenance Superintendent
King County	Cameron Satterfield	Communications Manager
KING-5 | TEGNA	Greg Thies	News Ops Mgr; Chief sUAS Safety Officer
Lakewood Police Department	Mike McGettigan	Police Officer
Lakewood Police Department, WA	Austin Lee	Police Officer / Lakewood Police UAS Coordinator
Macedonia VFD	Cody Dailey	Mr.
Mason County Sheriff's Office	Michael Sargent	Detective Corporal
Montgomery County, Kansas - Office of Emergency Management	Lee Miller	Clerk II
Multnomah County	Edwin Lopez	Safety & Health Specialist
Multnomah County Transportation Division	Tina LeFebvre	Admin Analyst
Multnomah County Transportation Division	Tina LeFebvre	Admin Analyst
Olympic College	Terry M. Reddick	Program Development and Research Specialist
Oregon Department of Transportation	Christopher Glantz	UAS Operations Coordinator
Organization	Name	Title
Pacific County Emergency Management Agency	Scott McDougall	Director
Pegasus Imagery Ltd	Cole Rosentreter	CEO
Pierce College, Fort Steilacoom	Morgan J Walker	Student
Port of Seattle	Russ Read	Security Manager
Port of Vancouver, USA	Todd Krout	Director of Operations
POrt Townsend Police Department	William Corrigan	Officer
Puyallup Police	Greg Massey	Detective
Puyallup Police Department	Jason Visnaw	Captain
Rogue Heart Media	Mike Robison	Remote pilot/ Cinematographer/ Editor
Seattle Department of Transportation	Patti Quirk	Acting Emergency Manager and Security Advisor
Skagit County Public Works	David Walde	Project Manager
Snohomish County	Ed Whitford	GIS Supervisor
Snohomish County Department of Emergency Management	Robert Thurston	SR GIS Analyst

Snohomish County Public Utility District	Maureen Barnes	Real Estate Manager
Snohomish County Volunteer Search & Rescue	Larry D. Warner	Remote Pilot Volunteer
Syracuse(NY) Fire Department	Timothy Gleeson	Captain
Tacoma Police Department	Scott A Harris	PPO
Tacoma Public Utility	Jason Stewart	Senior Management Analyst
The Ulven Companies	Steve Fournier	VP Sales and Marketing
Thurston Co. Public Works	Jim Moyer	Tech 2
Thurston County Public Works	Matt Balder	Assistant Design Engineer
Washington Department of Natural Resources	Abby Gleason	Lidar Manager/ITS4
Washington State County Road Admin Board (CRAB)	Jim Ayres	Engineering Design Systems Manager
Washington State Patrol	Jay Cabezuela	Captain
Wolf UAS, LLC	Mitch Droz	VP of Operations & Customer Experience
Yakima Police Department	Tory Adams	Sergeant

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CRDR
Center for Regional Disaster Resilience

Using Drones to Detect Damage to Bridges Workshop Agenda

December 13, 2018 | 8:30am-12:00pm
Clover Park Technical College- Lakewood, WA

8:30am	**Registration** Pastries and coffee provided.
9:00-9:15	**Welcome and Introductions** **Review of NIPP Project** Eric Holdeman, Director of Center for Regional Disaster Resilience
9:15-9:30	**Update on Drone Regulations and Usage in the Pacific Northwest** Tom Hagen, President of Association for Unmanned Vehicle Systems International Cascade Chapter
9:30-10:00	**Remote Sensing for Critical Infrastructure** David Tyler, Manager of IT/Telecommunications for Puget Sound Energy
10:00-10:10	Break
10:10-11:10	**Report on Technical Tools for Post-Disaster Damage Assessment** Taskin Padir, Associate Professor of Electrical and Computer Engineering at Northeastern University
11:10-11:20	**Using Drones for Synchronization of Situational Awareness: Introduction of Next Project** Eric Holdeman, Director of Center for Regional Disaster Resilience
11:20-11:40	**Gaining Access for Critical Infrastructure Inspections in Washington** Tristan Allen, Program Manager for Washington Emergency Management
11:40-12:00	**RAPID Facility Overview** Jake Dafni, PhD, PE, Operations Manager for NHERI RAPID Experimental Facility at the University of Washington
12:00	**Adjourn**